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Ministry of Environment and Energy
Denmark
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Introduction

The National Environmental Research Institute (NERI) carries out the Danish atmospheric emissions inventory and reports to the EU and international conventions such as the UNECE Convention on Long Range Transboundary Air Pollution (CLRTAP) and the UN Framework Convention on Climate Change (UNFCCC) under the Intergovernmental Panel on Climate Change (IPCC). The two international conventions deal with regional and global air pollution effects and this survey covers the pollutants reported to these conventions. The greenhouse gas emissions are also reported to the EU because EU - as well as the nations - is a party to the Climate Convention.

Reported pollutants and deadlines for reporting 1999-emission data:

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Deadline for reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNECE-convention</td>
<td>December 31 2000</td>
</tr>
<tr>
<td>SO2, NOx, CO2, CO, NMVOC, CH4, NH3, As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn, Dioxins, PAH</td>
<td></td>
</tr>
<tr>
<td>EU</td>
<td>December 31 2000</td>
</tr>
<tr>
<td>CO2, CH4, N2O, SO2, NOx, CO, NMVOC, HFCs, PFC, SF6</td>
<td></td>
</tr>
<tr>
<td>UNFCCC</td>
<td>April 15 2001</td>
</tr>
<tr>
<td>CO2, CH4, N2O, SO2, NOx, CO, NMVOC, HFCs, PFC, SF6</td>
<td></td>
</tr>
</tbody>
</table>

SO2 (sulphur dioxide), NOx (nitrogen oxides), CO2 (carbon dioxide), CO (carbon monoxide), NMVOC (non-methane volatile organic compounds), CH4 (methane), N2O (nitrous oxide), NH3 (ammonia), As (arsenic), Cd (cadmium), Cr (chromium), Cu (copper), Hg (mercury), Ni (nickel), Pb (lead), Se (selenium), Zn (zinc), Dioxins, PAH (polycyclic aromatic hydrocarbons), HFCs (hydrofluorocarbons), PFCs (perfluorocarbons), SF6 (sulphurhexafluoride).

The official Danish reports to UNECE (1999), EU (1999) and UNFCCC (1998) are available at NERI's homepage www.dmu.dk

The UNFCCC report for 1999 will be available at the homepage in April 2001.

Pollutants

The distribution of emissions on main sectors based on the emissions reported to UNECE for 1999:

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>SO2 ton</th>
<th>NOx ton</th>
<th>NMVOC ton</th>
<th>CH4 ton</th>
<th>CO ton</th>
<th>CO2 kton</th>
<th>N2O ton</th>
<th>NH3 ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion in energy and transformation industry</td>
<td>37145</td>
<td>55964</td>
<td>1699</td>
<td>17682</td>
<td>13325</td>
<td>28237</td>
<td>928</td>
<td>0</td>
</tr>
<tr>
<td>Non-industrial combustion plants</td>
<td>3293</td>
<td>6694</td>
<td>7904</td>
<td>9101</td>
<td>13080</td>
<td>1</td>
<td>184</td>
<td>0</td>
</tr>
<tr>
<td>Combustion in manufacturing industry</td>
<td>8536</td>
<td>15169</td>
<td>683</td>
<td>1318</td>
<td>6075</td>
<td>5293</td>
<td>151</td>
<td>0</td>
</tr>
<tr>
<td>Production processes</td>
<td>1359</td>
<td>451</td>
<td>5071</td>
<td>45</td>
<td>0</td>
<td>1402</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Extraction and distribution of fossil fuels and geothermal energy</td>
<td>0</td>
<td>0</td>
<td>5539</td>
<td>13404</td>
<td>23799</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Solvent and other product use</td>
<td>0</td>
<td>0</td>
<td>38535</td>
<td>0</td>
<td>0</td>
<td>120</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Road transport</td>
<td>1267</td>
<td>69258</td>
<td>46071</td>
<td>3073</td>
<td>269391</td>
<td>11358</td>
<td>1434</td>
<td>2049</td>
</tr>
<tr>
<td>Other mobile sources and machinery</td>
<td>4264</td>
<td>57837</td>
<td>20004</td>
<td>560</td>
<td>94826</td>
<td>3836</td>
<td>918</td>
<td>7</td>
</tr>
<tr>
<td>Waste treatment and disposal</td>
<td>50</td>
<td>4798</td>
<td>1349</td>
<td>55341</td>
<td>3099</td>
<td>900</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0</td>
<td>0</td>
<td>1191</td>
<td>168314</td>
<td>0</td>
<td>0</td>
<td>19735</td>
<td>93930</td>
</tr>
<tr>
<td>Other sources and sinks</td>
<td>0</td>
<td>0</td>
<td>14065</td>
<td>354238</td>
<td>0</td>
<td>976</td>
<td>7700</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>55912</td>
<td>210171</td>
<td>142143</td>
<td>623076</td>
<td>541316</td>
<td>56042</td>
<td>31066</td>
<td>95986</td>
</tr>
</tbody>
</table>

Time series and distribution of emissions on main sectors for 1999 are shown for SO2, NOx, CO2, CO, NMVOC, CH4, N2O and NH3.
SO₂

From 1998 to 1999 the SO₂ emission has decreased as much as 27%. This is mainly due to decreased consumption of coal while the use of natural gas and renewable energy has increased. The decrease is also due to continuous installation of desulphurization plants. But similarly to previous years the main part of the SO₂ emission originates from combustion of fossil fuels – mainly coal and oil – on public power plants and district heating plants. The relatively large fluctuations in the emissions are due to cross-country electricity trade. Thus the high emissions in 1991 and 1996 reflect a large electricity export.

NOₓ(NO + NO₂)

As for the SO₂ emission the NOₓ emission has decreased significantly from 1998 to 1999. This is due to reduced emissions from power plants as well as from road transport. Less export of electricity is together with reduced use of coal the reason for a reduction of 24% from the power plants. The drop in the emissions from road transport is caused by increasing use of catalyst converters and other techniques reducing the NOₓ emissions. The emissions from road transport have decreased with about 10% despite the fact that the energy consumption has increased.

CO₂

The actual CO₂ emission decreased 5% from 1998 to 1999. This was mainly due to less export of electricity and higher outdoor temperature in 1999 compared to 1998. But also the change of fuel from coal to natural gas and renewable energy has contributed to the lower emission. As a result of the lower consumption of coal in resent years the main part of the CO₂ emission comes from oil combustion.
CO

Road transport still has the dominant share of the total CO emission budget, but as seen for the NOx emission there has been a significant decrease from 1998 to 1999. This is due to increasing use of catalyst converters. Also other mobile sources and non-industrial combustion plants contribute significantly to the total emission of this pollutant.

CH₄

There are two large sources to CH₄ emissions: nature and agriculture. Natural sources contribute with more than half of the emissions and originate mainly from anaerobic processes in wetlands. The emission from agriculture derives from enteric fermentation and management of animal manure. From 1998 to 1999 the number of livestock has decreased resulting in a slight decrease in the emission.

NMVOC

The sources to emissions of NMVOC can be divided into two main types: Incomplete combustion and evaporation. The main sources to NMVOC emissions from incomplete combustion processes are road vehicles and other mobile sources such as sea vessels and off-road machinery. The emissions from road transportation vehicles have decreased with about 5% from 1998 to 1999 while the emissions from other mobile sources has increased with about 7% in the same period. The anthropogenic evaporative emissions mainly come from use of solvents in industries and households.
N$_2$O

Agriculture is the most important N$_2$O emission source. N$_2$O is emitted from agricultural crops and formed in soil from nitrogen in manure and fertilisers. Substantial emissions also come from drainage water and coastal waters where nitrogen is converted to N$_2$O through bacterial processes. However, the nitrogen in these processes originates mainly from the agricultural use of manure and fertilisers.

NH$_3$

Almost all atmospheric emissions of NH$_3$ result from agricultural activities. Only a minor part originates from road transport. This part is however increasing due to increasing use of catalyst cars. The main part of the emission from agriculture comes from manure (75%). Other contributions come from use of chemical fertilisers (7%), crops (15%) and ammonia used for straw treatment (2%).

Heavy metals, dioxins and PAHs

The emissions of heavy metals, dioxins and PAHs can be seen at NERI’s homepage. The dioxin emissions for 1999 are revised according to a new report from the Danish Environmental Protection Agency (Environmental Project No. 570, 2000).
The ammonia emissions from agricultural activities

The ammonia emission has decreased from 128 kton to 94 kton from 1985 to 1999. The reduction is primarily connected with manure management in spite of increasing animal production in the same period. The main reason for the drop in the emission is due to improved food utilisation resulting in less nitrogen excreted per unit produced. The basis for ammonia emission is then reduced.

At the same time the stable types for cattle and pigs have changed from traditional stables with solid and liquid fraction manure to a slurry system. Furthermore the capacity of storage facilities for manure has increased in the same period. As a consequence an increasing part of the manure has been spread in early spring resulting in less emission.

The increasing amount of slurry has made it more attractive to develop new application methods. During the 90’s an increasing part of the slurry has been spread with trail hoses instead of broad-spread with the traditional slurry broad-spreader. It mainly means less emission from slurry spread during the summertime. Since the middle of the 90’s the use of deep injection has been introduced as well, however, to a more limited extent. The last mentioned method reduces the emission to a few percent of the total nitrogen in spread animal manure.

The emissions from the other sources – use of fertilisers and ammonia to straw treatment – have decreased too. Finally, the agricultural area is reduced, and an area of 200,000 ha has been set aside, meaning a further reduction in the ammonia emission from crops.
Acidifying gases

The reduction of the emission of Danish acidifying gases in terms of acid equivalents. The most important acidification factor in Denmark is ammonia nitrogen. The emissions for all the acidifying gases have decreased since 1990, especially the emission of SO$_2$ has decreased markedly.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Base year</th>
<th>Target year</th>
<th>Reduction Target (%)</th>
<th>Reduction in 1999 (%)</th>
<th>Projected reduction in target year</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO$_2$</td>
<td>1980</td>
<td>2000</td>
<td>80</td>
<td>88</td>
<td>-</td>
</tr>
<tr>
<td>NO$_x$</td>
<td>1987</td>
<td>1994</td>
<td>0</td>
<td>11 (1994) 31</td>
<td>-</td>
</tr>
<tr>
<td>VOC</td>
<td>1985</td>
<td>1999</td>
<td>30</td>
<td>35</td>
<td>-</td>
</tr>
<tr>
<td>CO$_2$, N$_2$O, CH$_4$, HFC's, PFC's, SF$_6$</td>
<td>1990: CO$_2$, N$_2$O, CH$_4$, HFC's, PFC's, SF$_6$</td>
<td>1995: CO$_2$, N$_2$O, CH$_4$, HFC's, PFC's, SF$_6$</td>
<td>2008-2012</td>
<td>21$^2$</td>
<td>5</td>
</tr>
</tbody>
</table>

$^1$ EU Burden Sharing Agreement to achieve the EU 8% reduction target under the Kyoto-protocol (not yet ratified).

$^2$ Based on CO$_2$ emissions adjusted for import of electricity in 1990.

The target in the VOC-protocol is a reduction of 30% of the anthropogenic emissions from 1985 to 1999. This target is fulfilled by a reduction of 35%.

In the sulphur protocol under the UNECE-CLRTAP Denmark is obliged to reduce the SO$_2$ emission by 80% from 1980 to 2000. This target is likely to be met since the reduction was 88% in 1999. The general target in the NO$_x$ protocol is a stabilisation of the NO$_x$ emission at 1987 level in 1994. In this period Denmark achieved a reduction of 11% and in 1999 the reduction was 31%.

If the target in the Kyoto protocol is to be achieved, new actions in order to reduce the greenhouse gas emissions in Denmark are needed.

Greenhouse gases

Danish greenhouse gas emissions apportioned by type of total anthropogenic emissions in CO$_2$-equivalents. CO$_2$ is the most important greenhouse gas followed by N$_2$O and CH$_4$. The share from HFCs, PFCs and SF$_6$ is less than 1%. In contrary to the acidifying gases the reduction has been much less pronounced.

The reduction of the pollutants according to existing protocols.
**Literature**


**Contacts**

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The emission data used for presentation in this survey can be found at the internet address: [http://www.dmu.dk](http://www.dmu.dk)